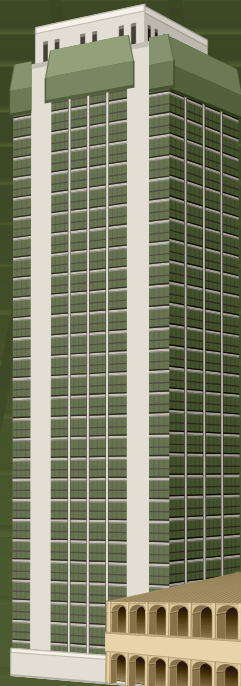


Physics in Law

- The Minneapolis Police Department has hired you as a consultant in a robbery investigation. A thief allegedly robbed a bank in the IDS Crystal Court. To escape the pursuing security guards, the thief took the express elevator to the roof of the IDS tower. Then, in order to not be caught with the evidence, she allegedly threw the money bag to a waiting accomplice on the roof of Dayton's, which is just to the west of the IDS tower (they are separated by the Nicollet Mall). The defense attorney contends that in order to reach the roof of Dayton's, the defendant would have had to throw the money bag with a minimum horizontal velocity of 10 meters/second. But in a test, she could throw the bag with a maximum velocity of no more than 5 meters/second. How will you advise the prosecuting attorney? You determine that the IDS tower is 250 meters high, Dayton's is 100 meters high and the Mall is 20 meters wide.

Physics in Law

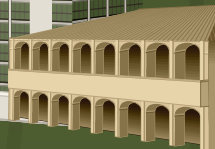
IDS
tower



Dayton's



mall



Project

- Observe and compare a launched steel ball to a dropped steel ball.
- Describe and explain your observations.

Lesson #17

Topic: Independence of Vectors

Objectives: (After this class I will be able to)

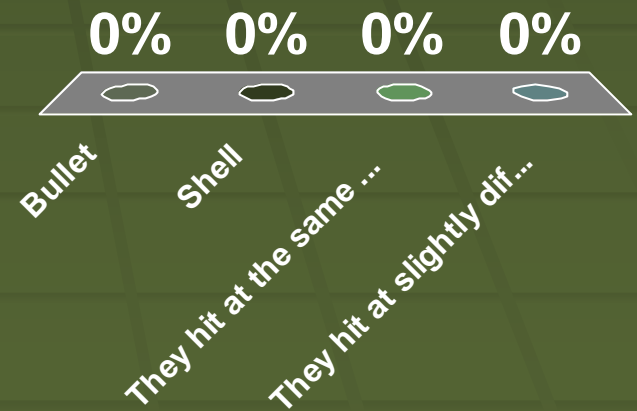
1. Observe and describe simultaneous horizontal and vertical motion.
2. Analyze and explain projectile motion.

Warm Up: A hunter is standing upright and fires a shot off at a deer. He fires the rifle completely horizontally. The empty shell is released from the chamber of the gun at the same moment the bullet leaves the barrel. If he misses the deer, does the bullet or empty shell hit the ground first?

Assignment: “Concept Development 3-1” Due Tuesday!

Does the bullet or empty shell hit the ground first?

1. Bullet
2. Shell
3. They hit at the same time
4. They hit at slightly different times but I'm not sure which one hits first

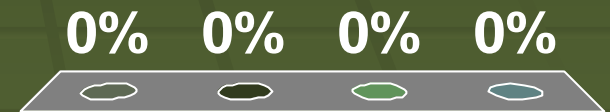


Independence of Vectors

- The X component of a vector will not affect or change the Y component of that vector.
- Example: A ball fired horizontally will hit the ground at the same time as a ball dropped from rest.
- The horizontal velocity does not change the time it takes for an object to hit the ground.
- The vertical acceleration does not increase or decrease the horizontal velocity. ($v_x = \text{constant}$)
- Objects can have a constant horizontal velocity and a vertical acceleration happening simultaneously.
- We call this situation projectile motion.

Which of the following is False?

1. The horizontal component of a projectile is constant
2. The vertical component of a projectile is constantly accelerating
3. The larger the horizontal velocity, the longer the object stays in the air
4. A dropped ball and a ball thrown horizontally from the same height will hit the ground at the same time



The horizontal comp...

The vertical compone..

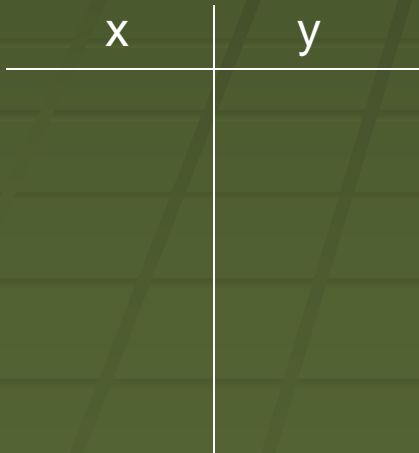
The larger the horizont..

A dropped ball and a ...

Practice Problem

- A car is driving towards a cliff at a constant speed of 20m/s . If the cliff is 45 m tall, what is the distance from the bottom of the cliff to the point where the car lands?
(Draw a picture to guide your thinking)

Givens



Project

- Walk at a constant speed and drop a ball into a ring.
- p150 Practice problems #1-3

Lesson #18

10/16/06

Topic: Lab: Independence of Vectors

Objectives: (After this class I will be able to)

1. Analyze the vertical and horizontal motion of the same object.
2. Calculate where a projectile will land given horizontal velocity and distance it will fall.

Original Task: Get a steel ball to roll off the lab table and into a Bull's-Eye on the floor on the first try.

Project

- Play catch with a partner.
- Observe the motion of the object and be able to describe...
 1. The horizontal component of distance
 2. The vertical component of distance
 3. The horizontal component of velocity
 4. The vertical component of velocity
 5. The horizontal component of acceleration
 6. The vertical component of acceleration

Lesson #19

Topic: Describing Projectile Motion

Objectives: (After this class I will be able to)

1. Draw a picture of a projectile and the x and y components of its velocity.
2. Describe how the velocity components of a projectile change during its flight path.

Warm Up: A person wants to shoot a monkey hanging from a tree with a slingshot. Should he aim above the monkey, below the monkey, or at the monkey? What if the monkey leaves go of the branch at the same time he fires the slingshot?

Assignment: "Tossed Ball" handout due tomorrow

If the monkey drops at the same time the gun is fired, you should aim...

1. Above the monkey
2. At the monkey
3. Below the monkey
4. Wait till he drops and then chase him down



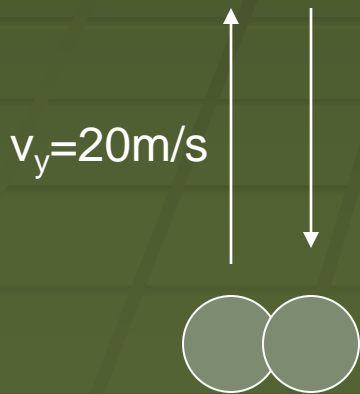
University of Minnesota Demo

- Shoot the monkey!

Velocity of a Projectile

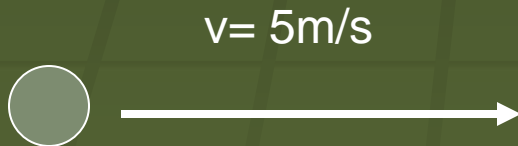
- The resultant velocity of a projectile at any instant is dependent on its horizontal and vertical components at that moment.
- The vertical component is the same as an object undergoing vertical acceleration. (a ball tossed straight up)

How long does the ball stay in the air?



Velocity of a projectile

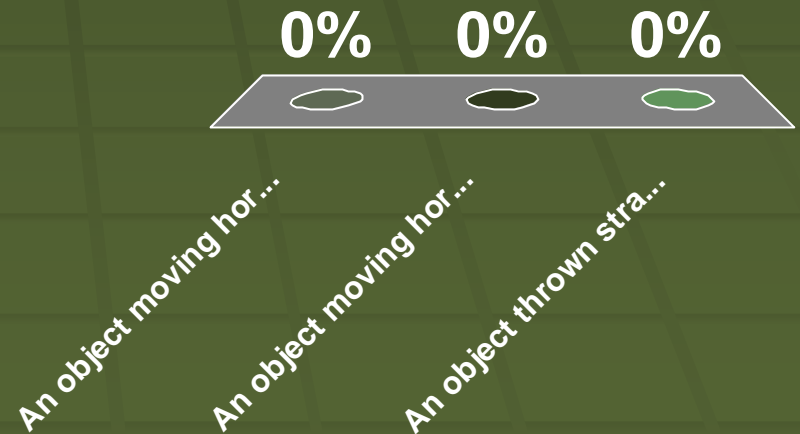
- The horizontal component is the same as an object moving horizontally at a constant speed.
(a ball moving in a straight path forward)



How far will this ball travel in 4 seconds?

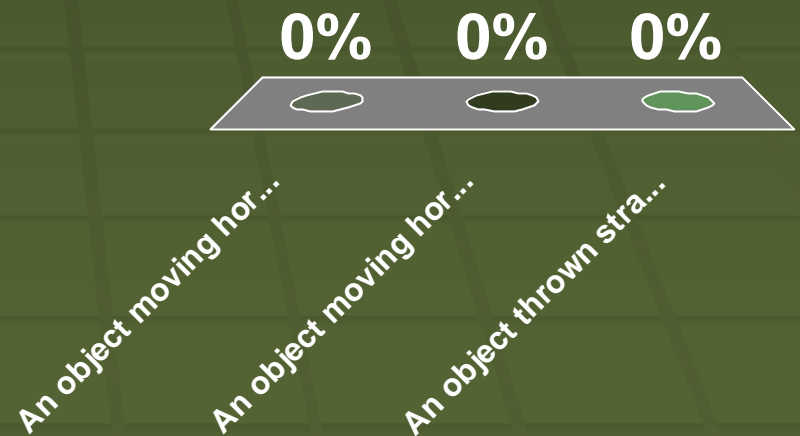
The horizontal component of a projectile can be treated as...

1. An object moving horizontally at constant speed
2. An object moving horizontally with an acceleration of 10m/s^2
3. An object thrown straight into the air

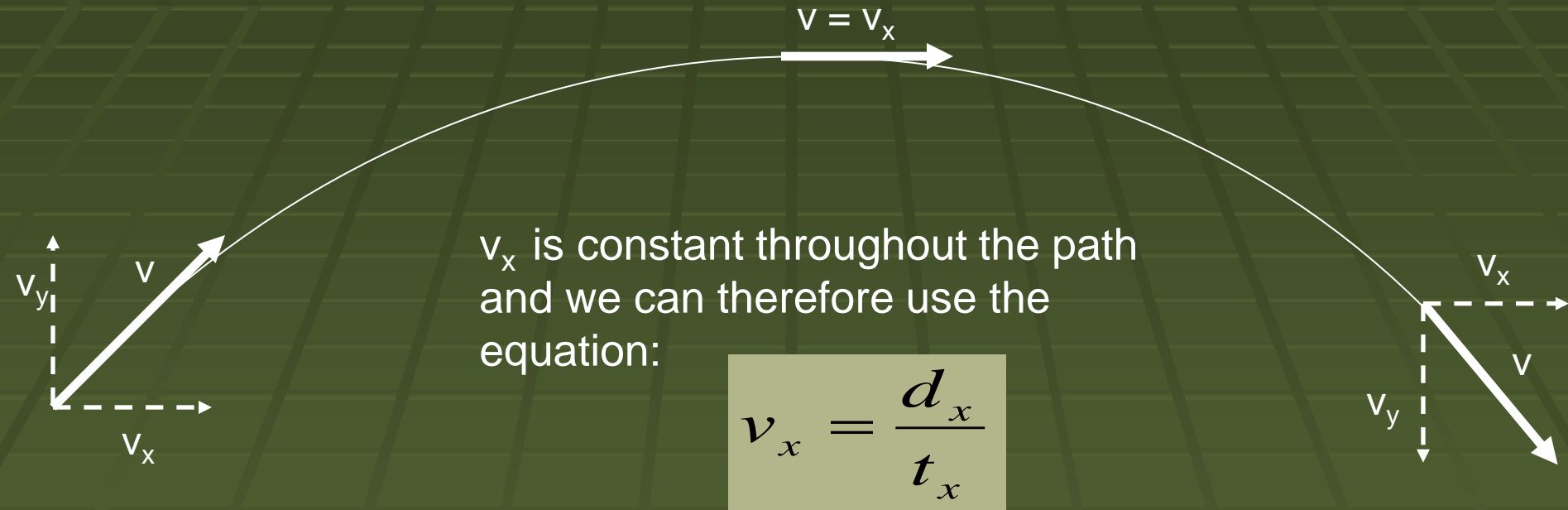


The vertical component of a projectile can be treated as...

1. An object moving horizontally at constant speed
2. An object moving horizontally with an acceleration of 10m/s^2
3. An object thrown straight into the air



Projectile Motion



v_y can be treated as an object thrown directly upward into the air and we can therefore use the equations:

$$v_{fy} = v_{iy} + gt_y$$

$$v_{fy}^2 = v_{iy}^2 + 2gd_y$$

$$d_y = v_{iy}t_y + \frac{1}{2}gt_y^2$$

Practice Problems

- Page 164-165 problems
#41, 43, 51, 52, 53

Complete “Physics in Law”

Lesson #20

Topic: Projectile Motion

Objectives: (After this class I will be able to)

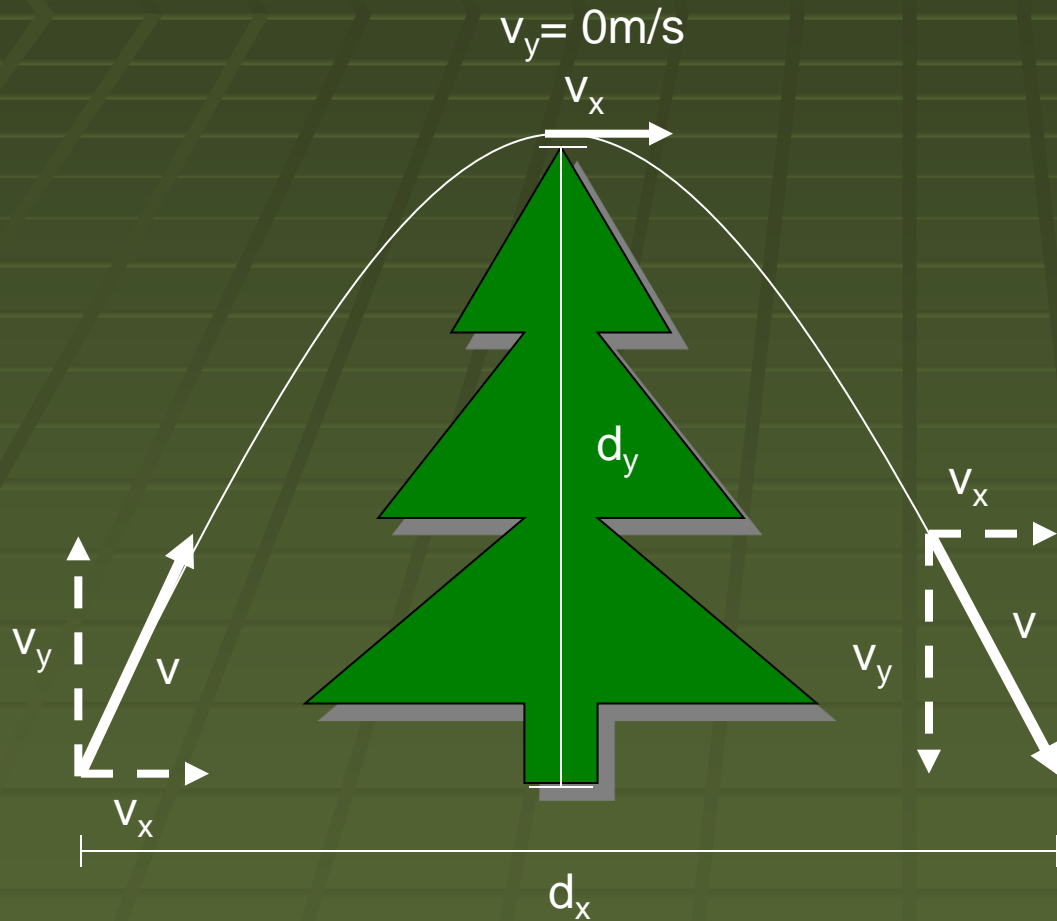
1. Calculate the resultant velocity vector of a projectile given v_x and v_y components.

Project: What is the height of the tree between the tennis courts and the school?

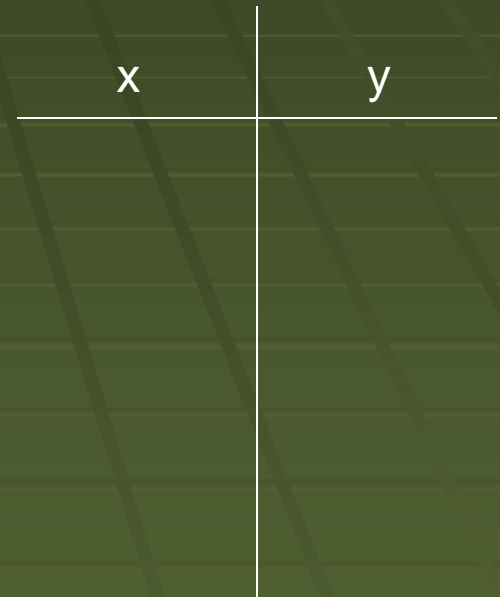
Assignment: Ch 6 p 164 – 165 #44, 46, 55, 58, 59

Example Problem

How tall is the tree next to the school?

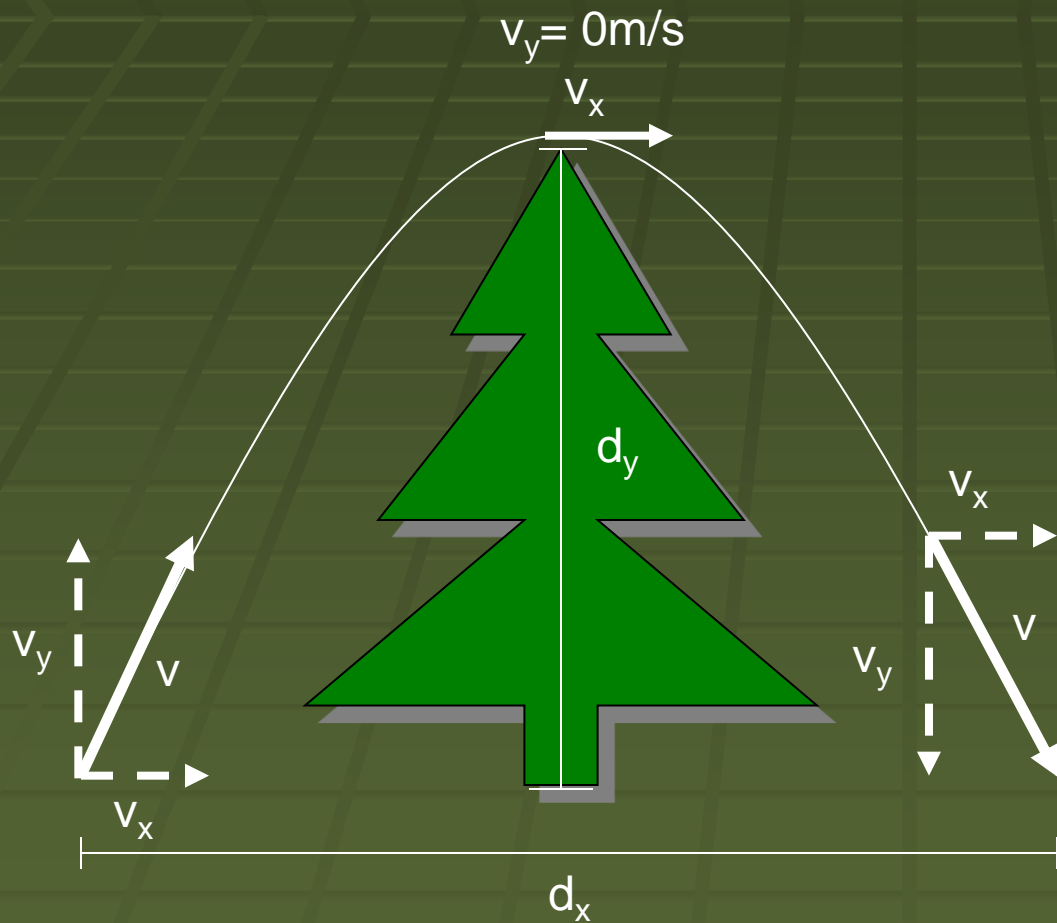


Givens

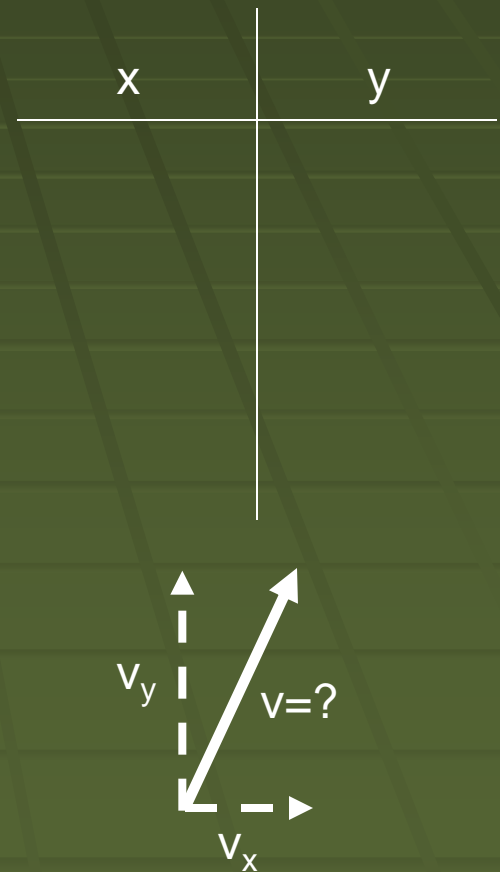


Example Problem

What was the initial velocity of the ball?



Givens



Practice Problem

- A kicker kicks a football 60m down the field. The ball's highest point is 35m above the ground. What was the initial velocity of the ball?

Practice Problem

- A model rocket carries no fuel; it is set in motion entirely by its ground level launcher. 8 seconds after being launched, the rocket lands on the ground 410m from the launcher.
- What is the initial velocity of the rocket?

Physics Movie Stunts

- Because of your physics background, you have been hired as a consultant for a new movie about Galileo. In one scene, he climbs up to the top of a tower and, in frustration over the people who ridicule his theories, throws a rock at a group of them standing on the ground. The rock leaves his hand at 30° from the horizontal. The script calls for the rock to land 15 m from the base of the tower near a group of his detractors. It is important for the script that the rock take precisely 3.0 seconds to hit the ground so that there is time for a good expressive close-up. The set coordinator is concerned that the rock will hit the ground with too much speed causing cement chips from the plaza to injure one of the high priced actors. You are told to calculate that speed.

Physics Movie Stunts



Lesson #21

Topic: Projectiles and Angles

Objectives: (After this class I will be able to)

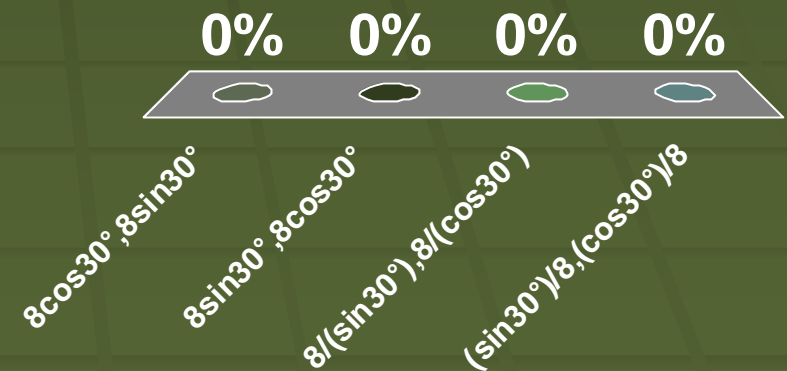
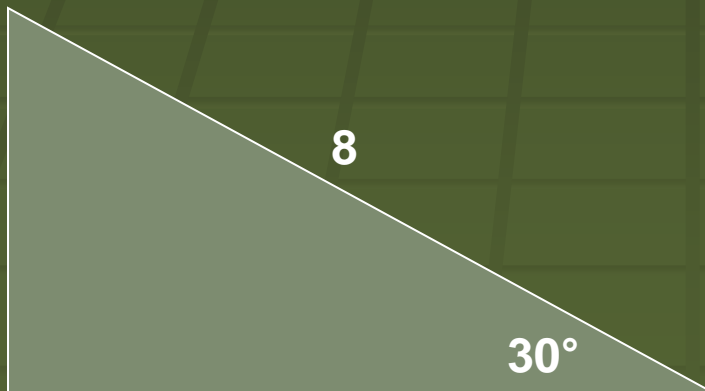
1. Draw and label vectors in a projectile motion diagram.
2. Use angles and trig functions to solve projectile motion problems.

Warm Up: A cannon ball is fired at an angle of 35° above the horizontal with a velocity of 60m/s. What are the initial x and y components of this velocity?

Assignment: "Ch 6 p 164 -165 #45, 56, 57, 60" due Tomorrow!

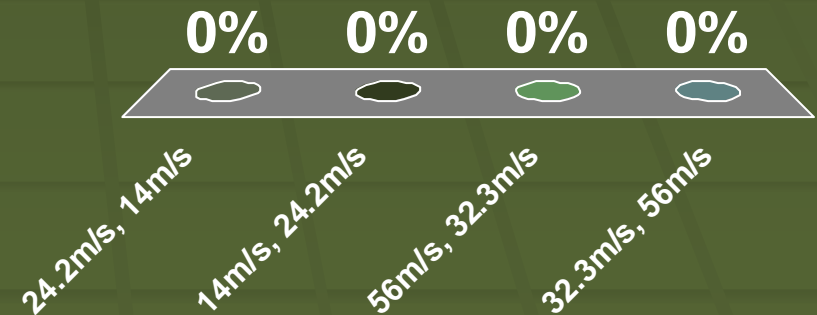
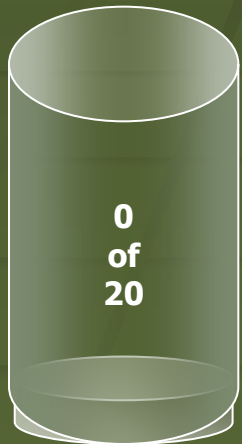
Trig review: What is the opposite side of this triangle? What is the adjacent side of this triangle?

1. $8\cos 30^\circ, 8\sin 30^\circ$
2. $8\sin 30^\circ, 8\cos 30^\circ$
3. $8/(\sin 30^\circ), 8/(\cos 30^\circ)$
4. $(\sin 30^\circ)/8, (\cos 30^\circ)/8$



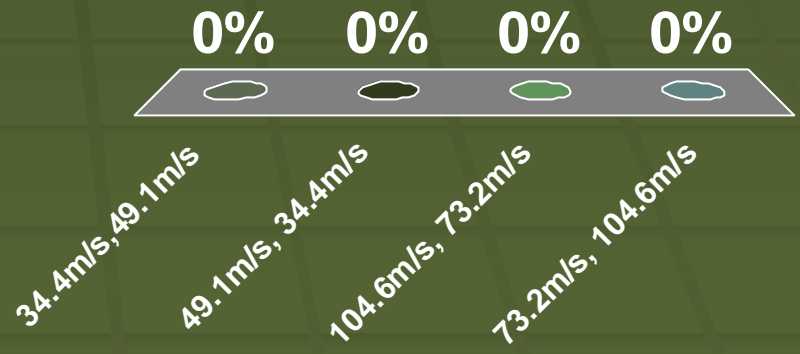
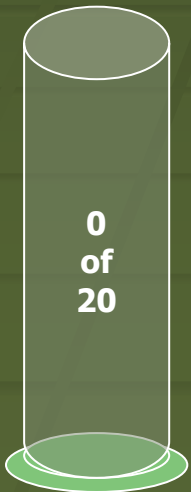
A projectile is launched with an initial velocity of 28m/s at an angle of 30° above the horizontal. What is v_x ? What is v_y ?

1. 24.2m/s, 14m/s
2. 14m/s, 24.2m/s
3. 56m/s, 32.3m/s
4. 32.3m/s, 56m/s



A cannon ball is fired at an angle of 35° above the horizontal with a velocity of 60m/s . What are the initial x and y components of this velocity?

1. $34.4\text{m/s}, 49.1\text{m/s}$
2. $49.1\text{m/s}, 34.4\text{m/s}$
3. $104.6\text{m/s}, 73.2\text{m/s}$
4. $73.2\text{m/s}, 104.6\text{m/s}$



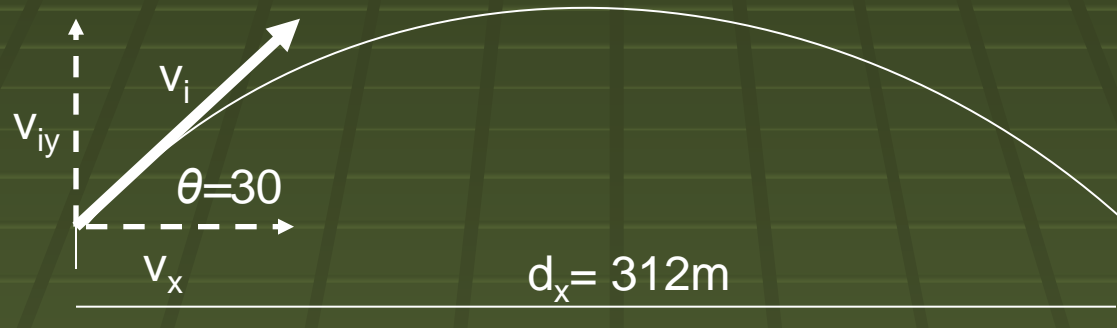
Practice Problem

- A ball is launched into the air at an angle of 60° above the horizontal. It stays in the air for 4 seconds. What is the initial velocity of the ball?

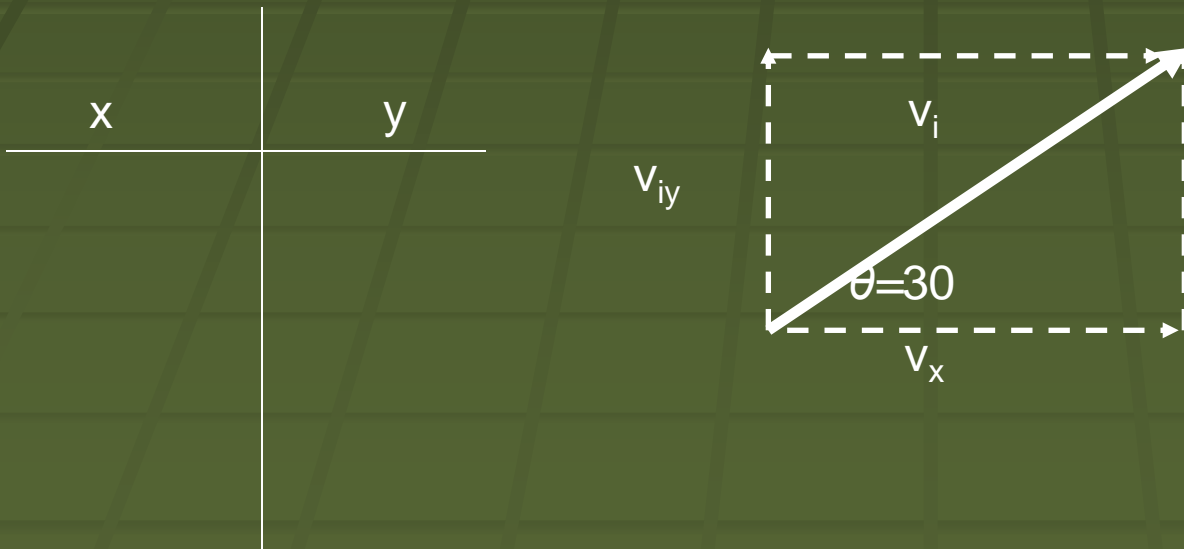
Example Problem

- Draw a projectile motion diagram and correctly draw and label all vectors for the following problem:
- A cannon is aimed 30° above the horizontal. It is fired at a target 312m away and stays in the air for 6 seconds. What is the initial velocity of the cannonball?

Example Problem



Givens



Assignment

- Ch 6 Supplemental Problems
- #1, 2, 4, 11, 12, 13

Assignment #2

Standardize Test Practice p169 #1, 6, 8

Complete Physics Movie Stunts

Lesson #22

Topic: Projectile Motion Exam Review

Objectives: (After this class I will be able to)

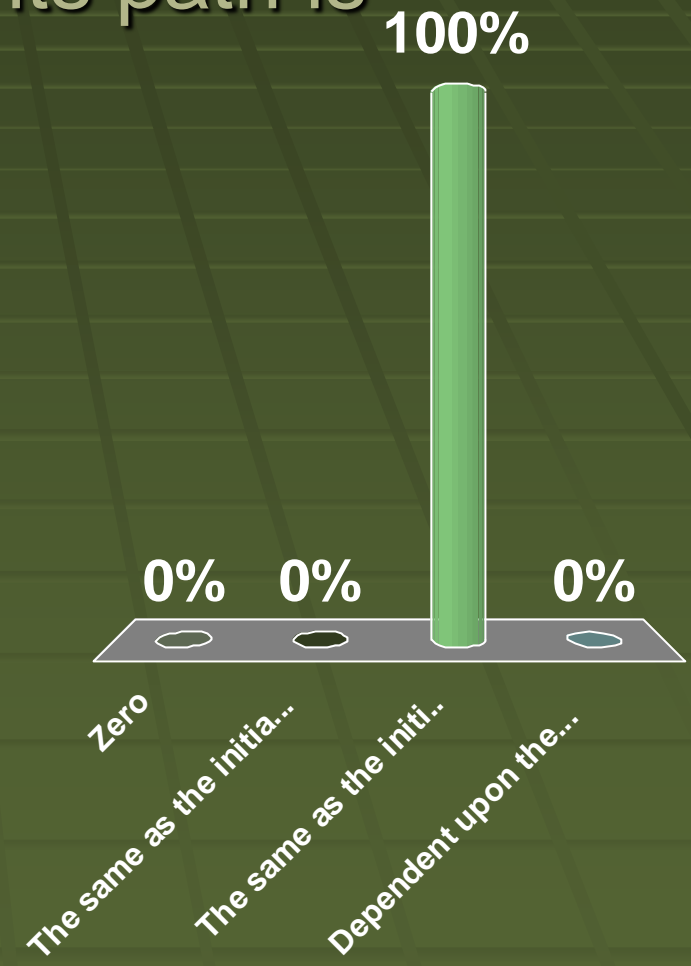
1. Practice solving physics problems
2. Complete and check Exam 3 Review
3. Plan a tutoring time (if needed)
4. Complete a bonus problem opportunity

Warm Up: A girl is sitting in a wagon pulled by her brother. The wagon is moving at 2m/s . She tosses the ball straight upward and the ball stays in her hand for 1 second. What is the initial velocity of the ball relative to the girl? What is the initial velocity of the ball relative to the ground?

Assignment: “Exam Review” due Tuesday
Projectile Motion Exam Tuesday!

A projectile is launched into the air at some angle above the ground. Its **horizontal velocity at the top** of its path is

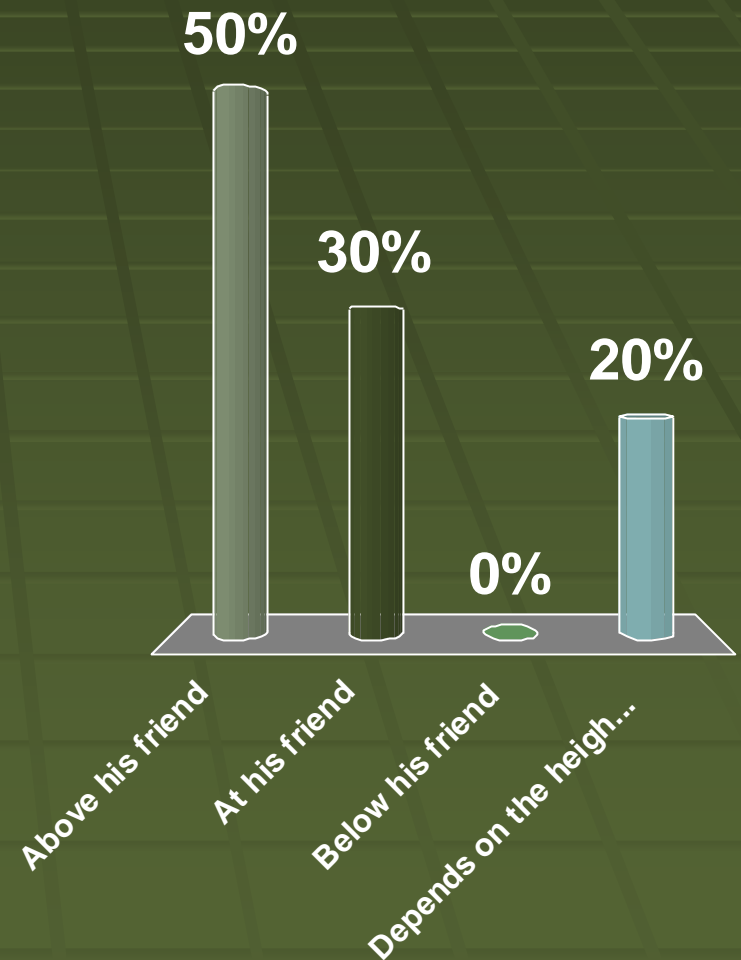
1. Zero
2. The same as the initial vertical velocity
3. The same as the initial horizontal velocity
4. Dependent upon the angle in which it was thrown



While on the ground trying to hit a friend in a tree house with a water balloon Joe should

aim

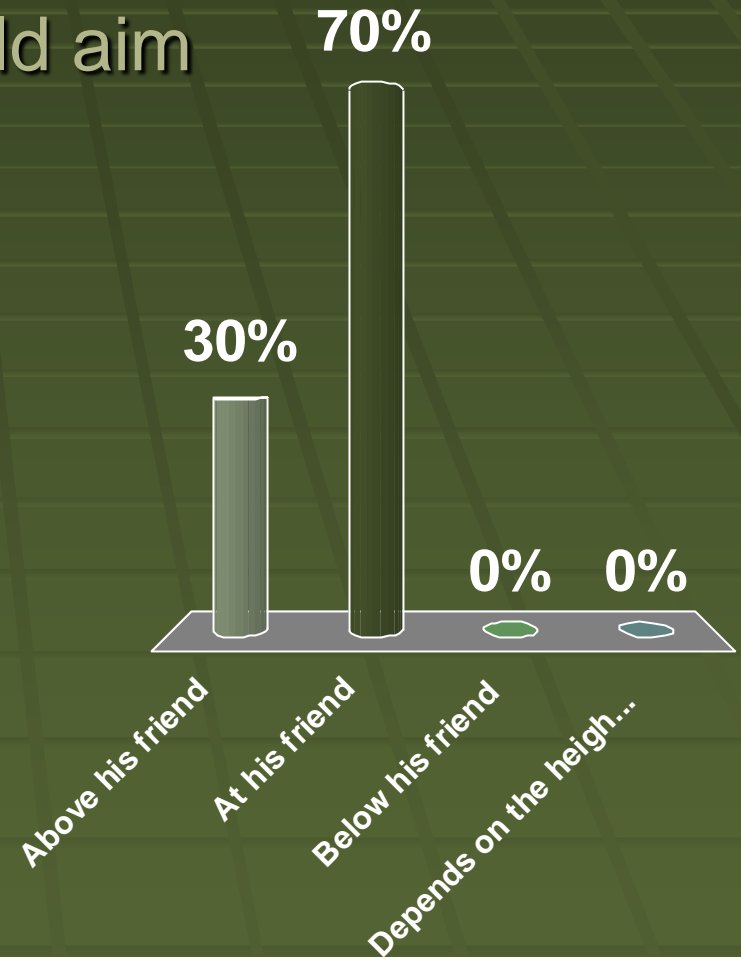
1. Above his friend
2. At his friend
3. Below his friend
4. Depends on the height of the treehouse



While on the ground trying to hit a friend jumping out of a tree house, Joe throws a water balloon just as his friend jumps out of the tree. In order to

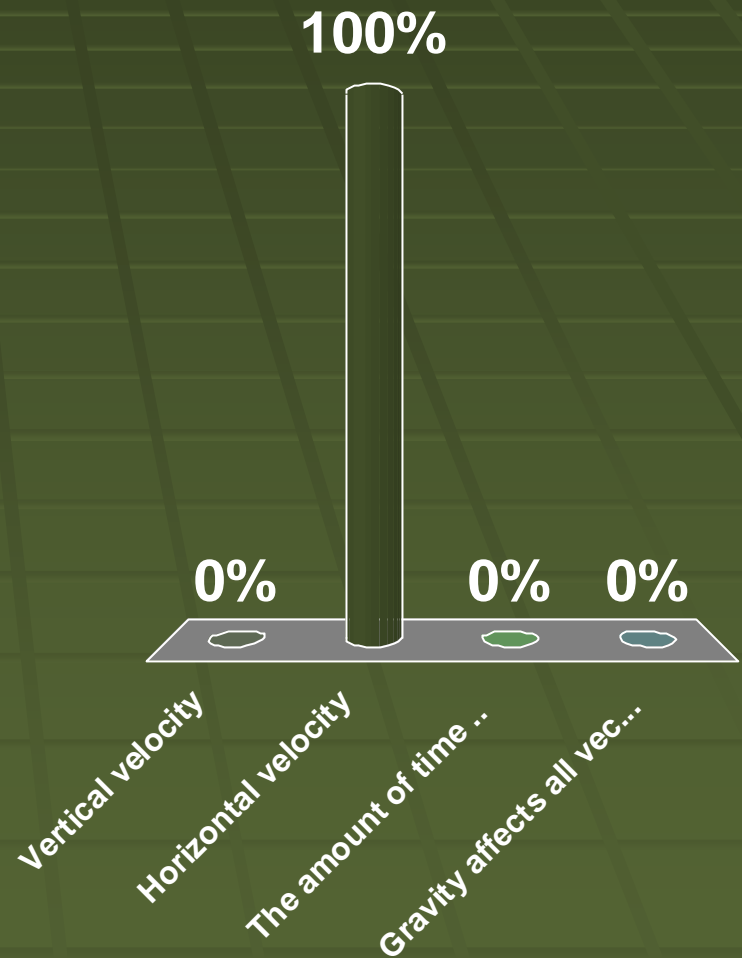
hit him he should aim

1. Above his friend
2. At his friend
3. Below his friend
4. Depends on the height of the treehouse



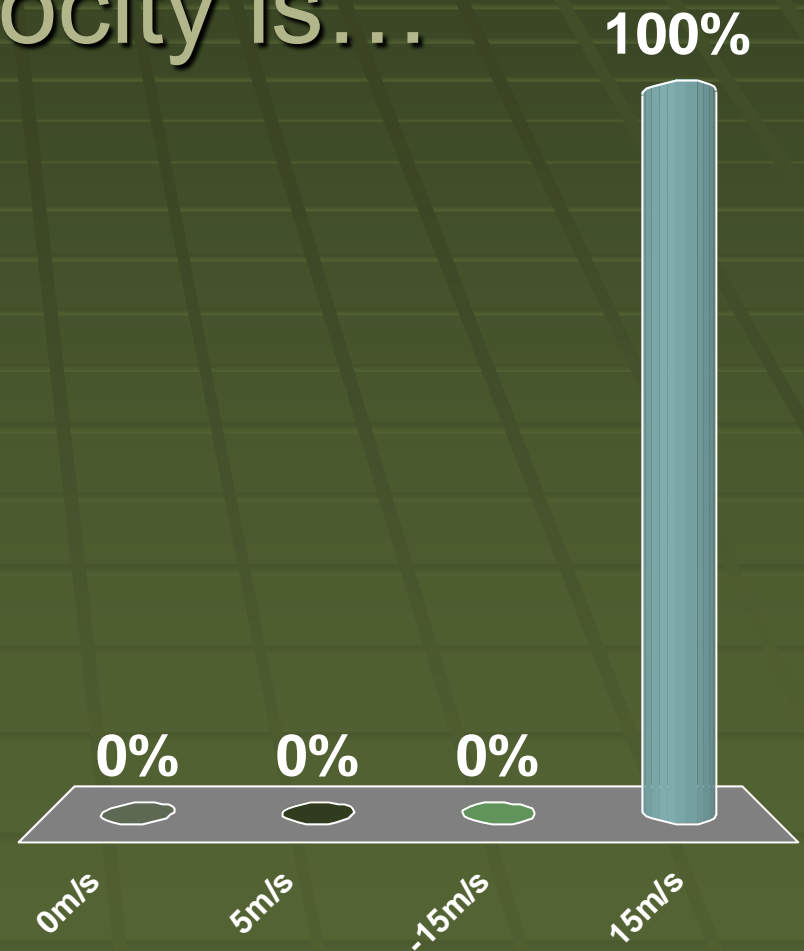
Gravity has no affect on

1. Vertical velocity
2. Horizontal velocity
3. The amount of time an object stays in the air
4. Gravity affects all vectors equally

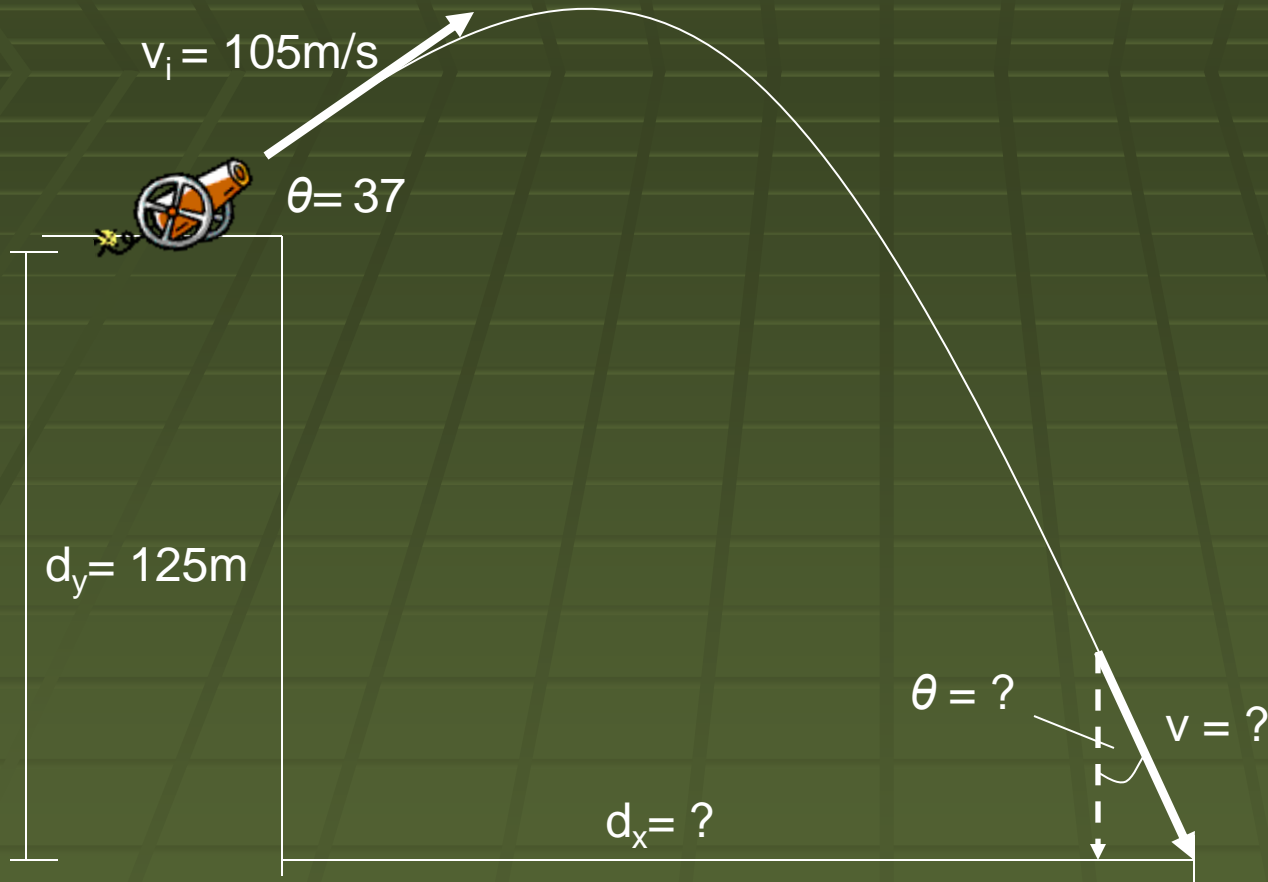


The initial horizontal velocity of a projectile is 15m/s . The final horizontal velocity is...

1. 0m/s
2. 5m/s
3. -15m/s
4. 15m/s



Bonus



Find: Horizontal distance traveled (2pts), Velocity the ball has when it strikes the ground (2pts), Angle to the vertical that the ball strikes the ground (2pts).